April, 1943 AIC-7

INFORMATION SHEET ON DEHYDRATED ONIONS*

Western Regional Research Laboratory, Albany, California
Bureau of Agricultural and Industrial Chemistry
Agricultural Research Administration
U. S. Department of Agriculture

Production

Onions are adapted to a wide range of temperature, but extensive commercial production is confined to sections that are particularly suitable to the growing of this vegetable. The leading onion-producing area is in New York, where the 1942 production was 163,000 tons, almost one-fifth the total national crop. The acreage in New York was 12 percent of the national total. Texas, with 150,000 tons, ranked second, with 17 percent of the production and 42 percent of the national acreage. The average United States yield per acre in 1942 was 7 tons. In the late-producing western States, the yield was 12 tons; in the eastern and central States, 10 tons.

During the early stages of growth of the onion, the temperature should be fairly cool and the moisture supply must be ample. As a rule, the largest yields are obtained where cool temperatures prevail. In the early producing states, the onion harvest begins in April and ends in June. The intermediate states harvest this crop during the summer months, and the late states--the eastern, central, and western--from August to October. The marketing period for late onions lasts 6 or more months after the final harvest, and extends to the late spring of the following year. In New York, the most popular varieties of onions grown are Early Yellow Globe and Ebenezer; in Colorado, Mountain Danvers; in Texas, Yellow Bermuda.

Varieties

The most common fault found with dehydrated onions is their lack of pungency. The Ebenezer, White Portugal, Red Creole, White Creole, and Yellow Danvers Flat are very strong onions and make an excellent dried product. In addition these varieties contain a high percentage of dry matter. The White Portugal makes an excellent product. The yield per acre is, however, low.

The sweet Spanish, the various Bermudas, and similar types of onions are probably too mild for dehydration purposes. Some of the more pungent varieties, like Australian Brown (Oregon Brown or Buckskin), may yield a bitter-flavored dried product under certain drying conditions but under other conditions, they make excellent products. Australian Brown has a high percentage of dry matter, is an excellent keeper, and could be used to extend the season of operation. It is difficult to peel, however.

There is considerable variation in percentage of dry matter among varieties of onions; in this respect the mild varieties are low, and the pungent varieties high. In general the dried product made from the pungent varieties keeps longer in storage.

* Supersedes Information Sheet ACE-168

Storage

In the northern States, onions are held in common storage during the winter months. Part of the crop in this section is cold stored, because after March there is likelihood of sprouting. The Globe varieties are the best keepers, although well-matured onions of the Spanish or Valencia types can be kept almost as long. The mild Bermuda types have a shorter storage life.

The most important requirement in onion storage is a controlled relative humidity ranging from 70 to 75 percent. Higher humidities may cause root growth and decay in the form of neck rot. A temperature of 32°F. is sufficiently low to keep onions dormant and reasonably free from decay, provided they are in good sound condition and well cured when stored.

Good ventilation should be provided in storage. If the onions are packed in sacks, they should be set off the floor 2 to 4 inches and space provided around each sack. The sacks are usually stacked in pairs laid crosswise, 5 or 6 sacks high, and sometimes placed on a framework of shelves to provide good ventilation. In some dis- [illegible] the onions are stored in slatted crates. Good storage stock can be kept 6 [illegible] nths

Preparation

[illegible] ions are usually received at the plant in sacks containing up to 100 pounds. To prevent overheating these are stacked until they are used. Handling is much more simple for this product than for most vegetables, because blanching is not required. The onions should be thoroughly washed and cleaned to remove soil and foreign material; then the outer, discolored layers are removed, after which the root base and top are cut off. The onions should be cut mechanically into slices or shreds ranging from 1/8 to 1/4 inch in thickness. In pilot-plant operations at this Laboratory, peeling and trimming losses have varied from 6 to 15 percent.

Blanching

The Federal and U. S. Army specifications for dehydrated onions do not require blanching of the raw material. There is evidence, however, that the storage life of dehydrated product is prolonged when it is blanched. If the onions are blanched, there is the possibility that the material may fail to meet existing specifications, since the appearance of the blanched product is less attractive than that of the unblanched. If blanched, it is recommended that the slices be loaded at the rate of approximately 1-1/4 pounds per square foot of loading surface, and blanched in live steam for 1 to 1-1/2 minutes. Prolonged blanching may cause a marked loss of pungency. The cut material should not be held longer than one hour before blanching or dehydration.

Dehydration

The moisture content of raw onions varies with the variety, maturity, locality, and storage conditions. Since moisture content influences the yield of dry product, it is important for the operator to know the moisture content of the material he used.

The approximate range in moisture content of raw onions is shown below, at the left. From these percentages the weight, in pounds, of water in onions per pound of "bone-dry" matter has been calculated and is shown also. The bone-dry matter must not be confused with the finished product, which contains a low percentage of moisture, as shown by the maximum percentages permitted under government specifications. The ratio of water to bone-dry matter in the raw product is useful to the operator because it shows him how much water is contained in the product and makes readily calculable the weight of water that must be removed.

Moisture in raw onions (percent)*		Lbs. water per Lb. bone-dry matter		Moisture specification (maximum percent)
Range	Av.	Range	Av.	
70.2-95.2	87.5	2.5-19.8	7.0	4.0

*From Chatfield and Adams: Proximate composition of fresh vegetables. U.S.D.A. Circular 146 (1931). Tests at the Western Regional Research Laboratory have shown a higher average ratio of water to bone-dry matter (8.8 instead of 7.0 to 1).

The drying ratio, or its converse, the drying yield, can be calculated from the change in moisture content of the material in the drying step alone. The drying ratio is the ratio of the weight of material entering the dehydrator to the weight of the same material as it leaves the dehydrator commercially dry. The drying yield, usually expressed in percentage, is the reverse ratio of the same two weights. These ratios are useful in the design of dehydrators and for comparing the prospective yields of product from different types of raw material, since it may usually be assumed without serious error that the moisture content of the prepared material entering the dehydrator is the same as that of the raw vegetable. The following values for drying ratio and drying yield were calculated in that way from the moisture ranges given in the foregoing table, with moisture content of the commercially dry product assumed to be 4 percent.

Drying ratio, lbs. entering dehydrator per lb. leaving it at 4 percent moisture		Drying yield (percent)	
Range	Av.	Range	Av.
3.2-20.0	7.6*	5.0-31.0	13.0*

*The drying ratio and yield corresponding to the average moisture content of onions observed in tests at the Western Regional Research Laboratory (8.8 pounds per pound bone-dry) are 9.4 to 1 and 10.6 percent, respectively.

The operator is more directly interested in the overall shrinkage ratio, that is, the weight of unprepared raw product required to yield one pound of finished product which meets specifications. This may also be expressed as the reversed ratio, usually as a percentage, and is then known as the overall yield. The overall shrinkage ratio is always substantially higher than the drying ratio, and the overall yield lower than the drying yield, because all weight losses incurred at various steps of the process, such as culling, washing, peeling, trimming, and inspecting, must be discounted. Averages and ranges are not included here, because these other losses vary widely, as shown on page 2.

For the dehydration of onion slices or shreds the following tray loadings for different systems of air flow are suggested for trial:

Cross circulation of air	Through circulation of air	Finishing bin
Lbs. per sq. ft. of loading surface		
1.0-1.3	3.0-8.0	A loading depth of 2 to 4 feet is probably satisfactory

riations between varieties and within a single variety due to maturity, cultural conditions, or storage conditions make it necessary to determine safe operating temperatures by trial. The general principle to be followed is that the finishing temperature shall be carried as high as possible without damage to the product. To serve as a guide the following temperature conditions for different systems of dehydration are suggested for trial:

Counterflow Tunnel

	°F.
Hot-end temperature	Not over 130 or 140
Wet-bulb depression at cool end	At least 25

Parallel-Flow Predrier

	°F.
Hot-end temperature	165
Cool-end temperature	Not over 145
Wet-bulb temperature	Not over 100
Wet-bulb depression at cool end	At least 30

Center Exhaust Tunnel

Primary end	As in parallel-flow predrier
Secondary end	As in counterflow tunnel

Conveyor-Type Drier--Through Circulation

	°F.
Primary end, first section:	
Dry-bulb temperature	165
Wet-bulb temperature	Not over 100
Primary end, second section:	
Dry-bulb temperature	145
Wet-bulb temperature	95
Finishing end:	
Dry-bulb temperature	130-140
Wet-bulb temperature	85-90

Bin Finishing Drier

	°F.
Dry-bulb temperature of air entering drier	120-130 (at least 10° lower than finishing temperature in dehydrator)
Relative humidity	10 percent or less

Cabinet Drier

	°F.
Starting temperature:	
Dry bulb	165
Wet bulb	Not over 100
Finishing temperature:	
Dry bulb	130
Wet bulb	80

As drying in a cabinet progresses, the dry-bulb and wet-bulb temperatures are lowered by steps until the desired finishing temperature is reached. The temperature changes are made on the basis of a time schedule previously determined by a pilot run in which the temperatures are lowered in steps as the moisture content of the product is lowered. Since moisture is lost rapidly at first, the temperature must be lowered after a relatively short time interval. Further adjustments are made after gradually lengthening intervals. Fully a half of the total drying time should be taken at the temperatures given above as finishing conditions.

Each operator will have to depend upon the method of trial and error and experience to arrive at the proper conditions. The suggestions given above on cabinet drying will supply the operator with a starting point for the trial-and-error investigations. It should be remembered that the conditions suggested may not in all cases give the best results.

Packaging

The packaging-room equipment and methods for dehydrated onions are typical of those required for other dehydrated vegetables that require portection from water vapor but not from air. A picking belt for the removal of defects, a shaker screen for the removal of fines, a jogging stand to increase the net weight per carton, and an over-and-under type of weighing scale are commonly used.

Government specifications for onions now limit the moisture content of flakes and slices to 4 percent. In practice, flakes are packed at 3.5 percent moisture content. Onion powder should have an even lower moisture content to prevent lumping since it absorbs moisture rapidly. Dried onions are fragile; this fact should be kept in mind during handling in order to keep the fines low.

Onion powder and flakes will absorb moisture in atmospheres above 20 to 25 percent relative humidity. In the room where onions are ground the atmosphere must be air-conditioned to 30 percent or less for the best results. The type of air conditioner in most common use is the silica gel absorption unit. Air conditioners depending on refrigeration for dehumidification are also effective. Both of these types lower the relative humidity by removing water from the air and thereby lowering the dew-point. Or the air may be simply heated, thus increasing the difference between the dry bulb and the wet bulb, but leaving the dew-point unchanged. The relative humidity of the air, however, is reduced.

Export shipments for the U. S. Army are now being made in hermetically sealed 5-gallon, square tin cans. Cans of this type are made by a number of companies, any one of which will supply a suitable machine for sealing on the lids. This operation is so fast that in a production line 15 cans are sealed per minute. The number can be reduced if the operator of the sealer has other duties. Two cans are packed in a wooden case.

For domestic, civilian shipments a double waxed-paper liner in cartons can be used. Recently, shipments have been made in 5-gallon square cartons protected with a laminated lead foil. Those interested in this unit may write for AIC-9 on white potatoes, or AIC-8 on sweetpotatoes. The standard export package for these vegetables is the same as that now used in the domestic onion trade. The lead foil package has a much higher moisture-vapor resistance than the double liner mentioned.

Storage of Packaged Product

Dehydrated onions are quite sensitive to heat, as compared with white potatoes, which occupy a middle position in the scale of stability. Experience has shown that too high a temperature or too prolonged an exposure to a lower temperature causes a brownish color.

It is a good general rule that all vegetables should be cooled to 90°F. or lower within 24 hours after they are dried. It cannot be assumed that all of the requisite cooling will take place while the material is exposed on the picking belt. Completion of the cooling to 90°F. will take place satisfactorily after the material is packaged, if the packages are kept separate from others.

e rate of cooling will be very much slower if the cartons are stacked in a com-
ct pile; the cooling that will occur in an isolated carton in 7 hours will re-
ire 7 days in a compact double stack, and 7 weeks in a compact stack 4 cartons
ick. On the other hand, close stacking of cooled cartons in large blocks less-
s the rate at which heat will be absorbed. This fact can be used to advantage
en the product is in transit through warm regions The temperature of packaged
terial can be taken by placing a thermometer in the center of the carton and
ading after 10 minutes.

Inspection and Specifications

urchases of dehydrated vegetables for the several government agencies are in-
pected by the Fruit and Vegetable Branch of the Food Distribution Administration.
rocessing procedures are noted and the finished product is inspected for quality
cording to the specifications under which the purchase is made. Certificates
re ued only when inspections are m de on the sealed containers representing
p ent.

n order to facilitate inspection and as a direct aid to the manufacturer certain
should be followed. The packaged material should be coded and warehoused
oded lots. The coding can follow any system desired but should impart the
llowing information: Product, type, year, month, day, and shift.

amples are drawn at the rate of approximately 1 container per 100 and representa-
ive samples are taken. The containers are checked for condition and the net
eight determined by subtracting the tare weight from the gross. The entire con-
ents are removed from the can and mixed thoroughly A cross section is taken to
ake a composite sample and filled and sealed into previously dried jars. Exami-
ations for defects, uniformity of size, presence of fines, and color of dry pro-
uct can be made on the remainder and most of the material returned to the packer
or repackaging.

aboratory analyses are made to determine the moisture content, reconstitution,
nd other factors as outlined in the specifications under which the product is
eing graded. Upon completion of the inspection the results are forwarded to the
ontractor and purchasing agency. Official certificates are issued and dated ac-
ording to the date of the last day required to complete the analysis. These cer-
ificates serve as a basis for payment when the merchandise is received and ac-
epted.

urchases are made on Quartermaster Corps Tentative Specifications which are ob-
tainable through the Chicago Quartermaster Corps, 1819 West Pershing Road, Chicago,
Illinois, or on Tentative FSC Specifications obtainable through the Fruit and Vege-
table Branch of the Food Distribution Administration, U. S. Department of Agricult-
ure

Reconstitution and Quality

Dehydrated onions, both the powdered and the flake or slice form, are used commonly as seasoning agents. The dried flakes or slices can be rehydrated and used in salads or as seasoning in soups or other vegetable mixtures and in other products that require raw onions, or they can be rehydrated, stewed, and seasoned as a vegetable dish.

Soaking at room temperature or in an ice box in minimum amounts of water is the most suitable method of rehydration, and a minimum time of 2 hours is required. Unblanched onion pieces will take up enough water to make them turgid and crisp in that length of time. It is necessary to use enough water to insure wetting of all pieces. There is considerable transfer of pungent flavor to the water during soaking, and in directions for preparation the suggestion should be made by the producer that unabsorbed water be used in soup stock or meat gravy.

Operators of dehydration plants commonly make daily tests for quality on the material coming from the drier. These tests should include rate and completeness of rehydration and general quality of the dry and the rehydrated material. Rate and completeness of rehydration can be determined by soaking the product in 8 times its weight of water, draining, and weighing the rehydrated material. After soaking 2 hours a properly dehydrated onion will have reached 7 times its original weight. Draining for 2 minutes through an 8-mesh strainer is a suitable method.

Dehydrated onions should be crisp and succulent. They should have a mildly sweet bitter taste and a rich pungent odor. The color should be yellowish white to light yellow, depending upon the variety and drying conditions. Red onions should have yellowish-white centers with bright red outer rings.

Operators who wish to maintain uniformity of color in their product will find it most satisfactory to compare samples with standard color charts (such as Maerz and Paul's Dictionary of Color or the Munsell Book of Color, abridged edition); thus permanent records of acceptable colors can be made.

Dehydrated onions should be cooked only after rehydration, and the time of boiling should be as short as possible. White varieties are recommended for the preparation of dishes such as buttered or creamed onions.

For further detailed information, address the Western Regional Research Laboratory, Albany, California, or the Bureau of Agricultural and Industrial Chemistry, U. S. Department of Agriculture, Washington, D. C.

(Section portions of the material presented above were supplied by the Bureau of Plant Industry, Soils, and Agricultural Engineering, and Oregon State College.)